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## Simplified Complexity:

### Thinking in the White Spaces

by Gerry Gingrich

#### Conclusions

- Change, not stability, is the constant in today's world. Massive amounts of information flow around our global system in milliseconds, breaking down the borders of nation states and shifting the balance of power among old and new players. Widely separated and disparate places around our globe communicate across electronic networks in real time, reducing the effects of distance and time.
- Closer to home, America maintains its position as the leading edge player in the information society, adapting to the global information ebb and flow more quickly than any other nation on earth. We rethink our national security strategy more and more frequently, and the number and variety of relevant factors increase daily. Our public and private organizations continue to re-size, restructure, and reengineer. And our citizens enter new educational programs, lose and change jobs, and explore new models of management and leadership. As Carl Builder warns, it is a time for humility, not hubris.
- Military thinkers, politicians, scientists, and corporate executives are all looking for ways to understand the dynamics of global change and to prepare for the 21st century. Many are looking to the new science of complexity for answers. The science of complexity, however, does not yield answers, at least not in the sense that we have typically sought to describe our world and predict its events since the beginning of the Scientific Revolution. What it does yield is a new way of thinking about the world.

#### Old or New: Simple or Complex

For the last 300 years, Western science has progressed through the discovery and accumulation of "laws," each judged and measured against the aesthetic of simplicity. Laws that are simple are better than those that are complex. In contrast, the new way of thinking is ruled by an aesthetic of complexity. Empowered by the computer and the powerful manipulations it makes possible, this new thinking focuses on complex phenomena. Indeed, the new way of thinking assumes that many worldly phenomena are complex, not simple, and that *ipso facto*, the scientific description of these phenomena must also be complex.

As a framework for illustrating the differences between the old and new ways of thinking, consider regression analysis, a popular technique used by both the hard and soft sciences to model worldly phenomena. Regression analysis develops mathematical models to describe the functional relationship between a phenomenon,  $y$ , and a set of variables,  $x_1, x_2, \dots, x_n$ . Old thinking, the traditional paradigm of Western science, argues in favor of simplicity. So the fewer the  $x$ 's in the regression model, the better. Thus we have typically built our regression models of political and economic phenomena by starting with a very small number of variables and adding new ones *only* if they are statistically important. For example a traditional political scientist might use the two variables of military strength and economic health to build the first iteration of a hypothetical model describing the possibility of an outbreak of a major regional conflict (MRC) such as the Persian Gulf War. Additional variables might be useful for a full understanding of the nature of MRCs, but unless the political scientist can prove that they're statistically important, they'll be excluded from the model.

New thinking, or the complexity paradigm, would build its first iteration of a regression model by including *all* the variables relevant to describing and understanding the complex MRC phenomena. So a nontraditional political scientist might create the first iteration of a MRC model by including the variables of military effectiveness, political leadership, and civil-military balance in addition to the variables of military strength and economic health. Each of the five variables would remain in the final model as long as it was not proven to be statistically insignificant.

In short, old thinking is exclusive and new thinking is inclusive. But more importantly, old and new thinking can result in dramatically different final models. A well-known quirk of regression analysis is that the process of model building itself, for example the order in which variables are entered into the equation, affects the form of the final model. Thus a final model built with the complexity paradigm can be both qualitatively and quantitatively distinct from a final model built with the traditional scientific paradigm. In this way, new thinking leads intrepid explorers into the "white spaces"—areas of thought and discovery not covered by old thinking and the traditional academic disciplines.

It's important to note that not everyone is interested in the new science of complexity. Indeed historians sometimes point out that, for them, there is "nothing new" in the new science of complexity and the new thinking. Historians and other humanities scholars have been constructing complex understandings of reality for as long as people have been interested in learning about the world around them. The humanities have their intellectual roots in the philosophers and thinkers of two and three thousand years ago, long before the Scientific Revolution occurred.

In contrast most hard sciences were developed after the 17th century and closely follow the traditional Western scientific paradigm with its emphasis on simple laws and simple representations of worldly phenomena. And the majority of the soft sciences, such as political science and economics, have "aped" the hard sciences and followed the same paradigm. There are a few exceptions, but they tend to be infrequent, unrecognized, or ignored. In his brilliant description of scientific progress in the Western world, *The Structure of Scientific Revolutions*, Thomas Kuhn explains why methods and "ways of knowing" that are not compatible with the dominant paradigm are perceived as anomalous. Beware to scholars who ignore the aesthetic of simplicity!

### **Old or New: Linear or Nonlinear**

The aesthetic of simplicity drives another characteristic of the traditional Western paradigm, that is, the ubiquity of linear thinking. But what exactly *is* linear thinking? Again the modeling technique of

regression analysis provides a useful intellectual framework for illustrating the differences between old and new thinking. This time consider linear regression, the most frequently used form of regression analysis. Linear regression models describe the functional relationship between a phenomenon,  $y$ , and a set of variables,  $x_1, x_2, \dots, x_n$  using the equation of a line. In general linear regression models take the form:  $y = b + a_1x_1 + a_2x_2 + \dots + a_nx_n$ , where  $a_1, a_2, \dots, a_n$  and  $b$  are constants. All  $x$ 's are raised to the first power and all  $x$ 's are combined with all other  $x$ 's additively.

When all the variables in a linear equation are raised to the first power, the equation exhibits "proportionality": increases in an  $x$ -value result in proportional increases in the phenomenon. For example, given the equation,  $y = 3 + 10x_1 + 4x_2$ , a one unit increase in the variable  $x_1$  leads to a 10 unit increase in  $y$ . The next one unit increase in  $x_1$  also leads to a ten unit increase in  $y$ , as does each additional one unit increase in  $x_1$ . Similarly, each one unit increase in the variable  $x_2$  leads to a four unit increase in the phenomenon under study.

Proportionality is a comfortable thing. It lets us know that when we change one side of a linear equation, the other side changes at a constant rate. In other words, changes to the inputs of a system lead to constant changes in the output of that system. Such a relationship between inputs and outputs is simple, easily understood, and predictable. For example, proportionality exists when each five percent increase in the DoD budget translates into a one percent increase in military readiness, or when each one percent increase in the Federal Funds rate results in a one-half percent decrease in inflation. For our hypothetical major regional conflict (MRC) example, a decline in either variable—military strength or economic health—leads to a constant and thus predictable increase in the possibility of an MRC.

Because proportionality is simple and easy to understand, we rely on it heavily in our traditional thinking. In fact, it's difficult to think in any other way. Just contrast the simplicity and predictability of proportional relationships with the complexity and unpredictability of nonproportional relationships. The universe of nonproportional relationships is so varied and so large that the human mind can not even imagine all the possible alternatives. And most nonproportional relationships, by definition, exist in the white spaces. And thinking in the white spaces is ambiguous and uncertain, sometimes netting us nothing more than the frustrating awareness that we simply do not understand. Easier to stick to the traditional paradigm of proportional relationships!

Proportionality is not the only characteristic of linear thinking, however. The second requirement of a linear model is that all  $x$ 's are combined with all other  $x$ 's additively. The characteristic of "additivity," like that of proportionality, renders our thinking simple, easy, and comfortable. When variables are additive, models can be decomposed; that is, variables can be separated from one another, studied individually, and added back together to obtain the complete picture. Decomposition implies that the described phenomenon  $y$  is equal to the sum of all the individual variables, or that the whole is equal to the sum of its parts. Thus there is no problem so difficult that it can't be solved by breaking it into smaller and smaller pieces that can then be analyzed individually to obtain results that are, in turn, added back together to obtain the final solution.

Consider our major regional conflict (MRC) example again. The traditional political scientist breaks the problem into two separate pieces—the variable of military strength and the variable of economic health—and studies each one in isolation. When sufficient understanding of both variables is reached, they are translated to a common measuring stick and then added together to achieve a description of MRC outbreaks. Thus with additivity and decomposition, old thinking assumes away any relationship between the variables of military strength and economic health, and so continues to "keep it simple."

In contrast, the new thinking paradigm of complexity assumes that military strength and economic health are *not* independent, that there are interdependencies between the variables. Military strength and economic health cannot be decomposed and studied in isolation. Rather they are integrally related as part of a larger system in which the whole is something significantly different from the simple sum of its parts; the variables and their interdependencies must be studied together as one system. So new thinking leads to a more sophisticated understanding of the MRC phenomenon. And again it probably occurs in the white spaces untravelled by traditional linear thinkers.

### **Old or New: Universal or Specific**

In addition to simplicity, traditional Western science has progressed by judging and measuring its laws and models against another aesthetic of beauty and perfection, that of universality. All other things being equal, laws that explain more of the universe are better than those that explain less. Laws are universal when they explain or describe all of the varied events of a certain type under all conditions. The aesthetic of universality drives the search for the Theory of Everything (TOE) and its current incarnation, superstring theory. The simpler are our scientific laws, the more likely they are to be universal, and thus the aesthetics of simplicity and universality reinforce one another.

The complexity paradigm again encourages that which the traditional Western paradigm does not. New thinking does not search for universal laws but rather encourages "specificity"—the identification of all variables and parameters necessary to fully describe a *particular event*. If an event is important enough to be studied, then it's important enough to be specified in detail—only then can it be understood. The aesthetics of complexity and specificity reinforce one another just as the aesthetics of simplicity and universality do: the more complex is a law, the more likely it is to be specific.

Revisiting our hypothetical model of major regional conflicts one last time, recall that the aesthetic of complexity suggested a model with five, not two variables, as well as interdependencies between the variables. Now, the aesthetic of specificity suggests the use of additional variables if we are to fully understand and describe the MRC phenomenon. For example, MRCs occur within the context of a global environment so additional variables might specify global conditions such as economic trading communities, international information flows, and non-state coalitions. And we might include variables that capture the temporal context of the MRC phenomenon; certainly the possibility of an MRC differs at different points in time.

Thus new thinking, or the complexity paradigm, can create a model and an understanding of major regional conflicts that could not be developed by our traditional scientific paradigm and its simple, linear, universal models. Driven by the aesthetics of complexity and specificity, new thinking develops models that strengthen our understanding with increased numbers of variables; that build depth and sophistication with interdependent variables; that describe open systems subject to global conditions; and that capture political and economic phenomena as products of the era in which they occur. Operating in the white spaces, new thinking challenges us to defend our 300 year old thinking patterns: Are simplicity, linearity, and universality the only way to think about the world?

### **Recommendations**

- Finding "the truth" in a dynamic world of global change may involve thinking in a new way. The complexity paradigm may provide that new way for some national security problems. For example, phenomena such as the outbreak of major regional conflicts (MRCs) are highly complex. To achieve a full understanding of MRCs and other national security phenomena, we may need to

build complex models with many, interdependent variables instead of simple models with a few, independent variables.

- Our models and understanding of national security must increasingly encompass events in the larger global environment such as non-state coalitions and international trading communities.
- Our models of national security phenomena need to shift away from the Industrial Age assumptions of predictability and linearity to the Information Age assumptions of uncertainty and nonlinearity.

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